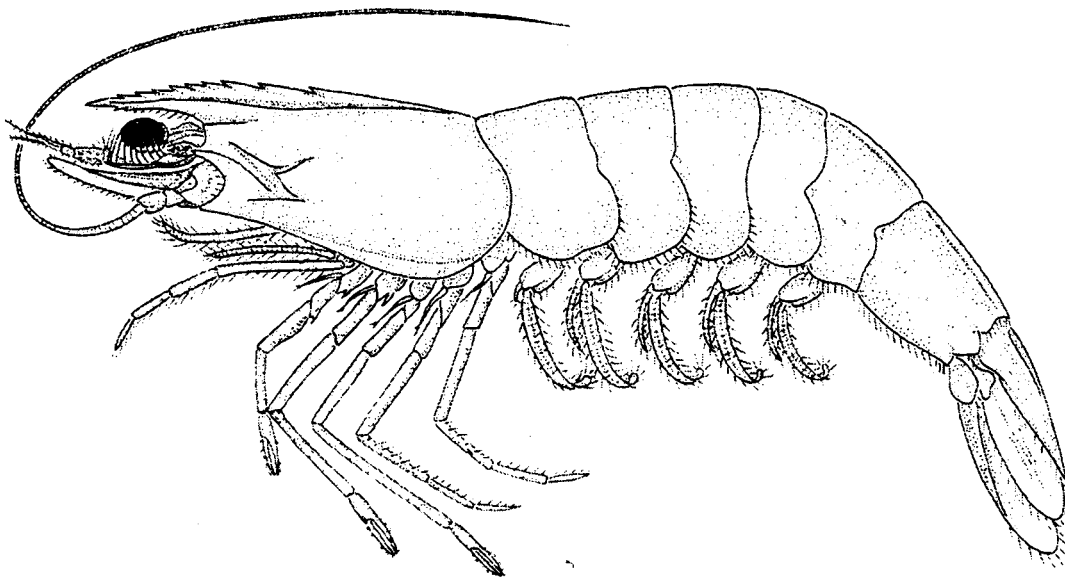


**An Evaluation of Potential Shrimp Virus Impacts
on Cultured Shrimp and Wild Shrimp Populations in the
Gulf of Mexico and Southeastern U.S. Atlantic Coastal Waters**



**A Report to the Joint Subcommittee on Aquaculture
Prepared by the JSA Shrimp Virus Work Group**

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LIST OF ACRONYMS

APHIS	Animal and Plant Health Inspection Service
BOD	Biochemical oxygen demand
CSREES	Cooperative State Research, Education, and Extension Service
DOC	U.S. Department of Commerce
EPA	U.S. Environmental Protection Agency
FWS	U.S. Fish and Wildlife Service
HH	High Health
IHHNV	Infectious Hypodermal and Hematopoietic Necrosis Virus
JSA	Joint Subcommittee on Aquaculture
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
PCR	Polymerase chain reaction
SPF	Specific Pathogen Free
ssRNA	Single-stranded ribonucleic acid
TSV	Taura Syndrome Virus
USDA	U.S. Department of Agriculture
WSSV	White Spot Syndrome Virus
YHV	Yellow Head Virus

PREFACE

Worldwide, shrimp aquaculture has suffered substantial economic losses due to pathogenic viruses, and the U.S. shrimp aquaculture industry is no exception. Although posing no threat to human health, the growing threat to shrimp aquaculture, concerns for possible effects on wild shrimp populations, and other species that depend on them have prompted action by the Joint Subcommittee on Aquaculture (JSA). The JSA is a Federal interagency advisory group formed under auspices of the President's Office of Science and Technology Policy. In March 1996, the JSA Executive Committee held an emergency meeting to discuss the shrimp virus situation and agreed to form a Shrimp Virus Work Group. In May 1996, the Shrimp Virus Work Group recommended to the JSA that the work group's primary task should be to develop an interagency strategy to address the shrimp virus issue. JSA accepted this recommendation and, in addition, decided to pursue the actions listed below.

- Identify existing authorities among Federal agencies.
- Identify research underway on shrimp viruses, their mode of transmission, and potential for introduction into U.S. waters.
- Support information exchange and education (i.e. workshop).
- Develop a risk assessment.
- Determine actions needed by the U.S. to avert introductions, etc.

The first three items were addressed during a June 1996 workshop. This workshop was jointly sponsored by: the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (DOC/NOAA/NMFS); U.S. Department of Agriculture, Cooperative State Research, Education and Extension Service (DOA/CREES) and Agricultural Research Service (DOA/ARS); and the U.S. Environmental Protection Agency (EPA), Gulf of Mexico Program and supported by the Gulf States Marine Fisheries Commission.. Workshop participants included environmentalists, shrimp farmers, shrimpers, processors and consumers as well as state and Federal regulators from both the U.S. and Mexico. The workshop presented the state of knowledge on the shrimp viruses and the threat they pose to both the shrimp culture industry and the wild shrimp populations in the Gulf of Mexico and southeastern U.S. Atlantic coastal waters. One of the highest priority recommendations made by workshop participants was to assess the disease, financial, and economic risks associated with the introduction and spread of exotic shrimp viruses to the wild shrimp fishery and shrimp farming industry.

Both workshop participants and the JSA have recommended that the risks associated with shrimp viruses be assessed, and this report is a first step towards that goal. Assembled by the Shrimp Virus Work Group, this report provides a summary of potential exposures to and effects of viruses on shrimp, especially wild shrimp populations. This report is structured according to (and draws material from) recently proposed processes for ecological risk assessment (Risk Assessment and Management Committee, 1996; U.S. EPA, 1996a).

Although this document is not a risk assessment, it is organized by elements of the risk assessment process. This approach:

- Provides a structure for analyzing and interpreting available information and for adding new information as it becomes available;
- Defines major risk-relevant data gaps, uncertainties, and research needs; and
- Indicates major pathways for virus introductions.

This report is intended to provide the JSA with a basis for discussing and selecting among a range of options for conducting a risk assessment.

EXECUTIVE SUMMARY

Recent evidence indicates that threats to the sustainability of U.S. marine resources due to exotic shrimp viruses are increasing. New, highly virulent diseases have been documented in foreign shrimp aquaculture operations. With its ever-increasing consumer demand, the U.S. has greatly increased importation of shrimp from areas of the world where shrimp viruses are endemic. Although these viruses pose no threat to human health, recent catastrophic outbreaks on U.S. shrimp farms, the appearance of diseased shrimp in U.S. commerce, and new information on the susceptibility of shrimp and other crustaceans to these viruses have prompted calls for investigation into the actual risks to domestic resources.

The Joint Subcommittee on Aquaculture formed the Shrimp Virus Work Group to assess the risks associated with these emerging pathogens. Risk assessments identify, organize, and prioritize information on potential risks. The Shrimp Virus Work Group produced this report to organize readily available information and expert opinion on the shrimp virus issue. This report closely follows the structure of a risk assessment while providing a summary of available risk-relevant information. To formulate the problem, this report includes an overview of economic impacts, a conceptual model for the assessment, stressors affecting shrimp populations, potential pathways for the exposure of wild shrimp to pathogenic viruses, basic life history of shrimp, and effects of viruses on shrimp and other aquatic species. Several options for completing an ecological risk assessment are proposed.

The economic significance of the shrimp virus problem should not be understated. Shrimp harvesting and processing in the United States is a \$3 billion dollar a year industry. A substantial portion of this industry includes harvesting of wild shrimp (200 million pounds of shrimp [tails] annually). Additionally, imports of shrimp into the U.S. for processing exceed 600 million pounds (tails) annually.

Exotic shrimp viruses may pose a risk to Gulf of Mexico and southeastern U.S. Atlantic fisheries, including economically-important penaeid shrimp as well as other crustaceans and fisheries that depend upon these shrimp. In fact, the impact of one virus on a wild shrimp fishery in Mexico has been documented. Beginning in 1987, harvestable populations of *Penaeus stylirostris* (as well as other less prevalent species) occurring in the upper and middle Gulf of California declined to levels which could not support commercial harvests until 1994, in association with the observed occurrence of Infectious Hypodermal and Hematopoietic Necrosis Virus (IHHNV) infection. This fishery only began to recover in 1994. Moreover, newly-identified Asian viruses (e.g., White Spot Syndrome Virus [WSSV] and Yellow Head Virus [YHV]) appear to be more virulent to U.S. native shrimp than viruses thought to be endemic to South and Central America (e.g., IHHNV and Taura Syndrome Virus [TSV]). However, these viral diseases have not yet been positively identified in U.S. wild shrimp populations. Research has not been conducted to characterize the risks of these viruses to the U.S. wild shrimp industry or to other ecologically important species, but techniques to identify these pathogens have only recently become available.

This report evaluates four major pathogenic shrimp viruses: IHHNV, TSV, WSSV and YHV. These four were selected not only because of their ecological and economic importance but also to cover a range of virulence and geographic origin, in view of available information. The findings of the Shrimp Virus Work Group are summarized below. While some of this information is not yet fully supported by scientific evidence, the potential severity and newness of the problem warrants the inclusion of all available information to highlight the importance of the issues and stimulate further investigation. Conducting a risk assessment will require experts in crustacean virology and biology and other related disciplines to evaluate the available data herein as well as to identify and utilize new and better sources of information. The strengths and limitations of the available data and information will be evaluated in the risk assessment.

Findings:

- Shrimp viral diseases are widespread throughout the world, both in wild and cultured shrimp. IHHNV and TSV are endemic in wild populations of shrimp throughout much of Central and South America. WSSV and YHV are endemic throughout much of Asia.
- In at least one incident, viral disease has been associated with drastic reductions in wild shrimp harvests. Beginning in 1987, one viral disease (IHHNV) was associated with a decline in the Gulf of California shrimp fishery to levels that could not support commercial harvests until 1994.
- Although these viruses have not yet been positively identified in native U.S. shrimp populations, very little effort has been expended to look for them. Where investigations have been conducted, analytical methods (if available) or sampling intensities may have been inadequate to detect infection.
- Viruses have affected cultured shrimp throughout the world, often with catastrophic effects on production. For example, imports from Chinese aquaculture operations dropped substantially (1990 to 1995) due in part to viral disease. Outbreaks in 1995 and 1996 on U.S. shrimp farms caused a 50 to 95 percent loss of production at affected farms.
- Despite extensive efforts to prevent outbreaks on U.S. farms by the U.S. Marine Shrimp Farming Program, state agencies, and producers, numerous disease outbreaks have occurred in 1995, 1996, and early 1997.
- There are major economic concerns at stake. The U.S. shrimp processing industry employs over 11,000 people in 182 companies. Any new requirements that may be necessary to reduce disease risks will increase costs to producers and processors, and ultimately to consumers.
- Some foreign aquaculture operations harvest their ponds immediately upon finding disease and export the infected shrimp. This management practice, combined with tremendous increases in shrimp importation, may increase risks to U.S. natural resources. Infected shrimp are now routinely found in U.S. retail markets.
- Shrimp may become infected from many sources. Major potential exposure pathways to wild shrimp in the U.S. include shrimp processing plant wastes and wastes and escapement from aquaculture ponds. Other potential viral sources include infected bait shrimp, ship

ballast water, non-shrimp translocated animals, and natural spread of the virus. Fishing vessels and intentional introductions are also possible sources.

- Domestic shrimp are vulnerable. Specific life stages of all of the principal U.S. shrimp species are highly susceptible to infection and disease from one or more of the four subject viruses as demonstrated in laboratory tests and outbreaks at aquaculture facilities. Recently discovered Asian viruses appear to be more virulent to domestic shrimp species than those viruses thought to be endemic to South and Central America.
- Species other than shrimp may be at risk. One or more of these viruses have been found in samples of other crustaceans from around the world, including copepods, crabs, shore flies and crayfish. A number of alternate host species for the viruses have been identified.

In response to these findings, the Shrimp Virus Work Group recommends that an ecological risk assessment be conducted. A formal risk assessment will help address international trade issues (e.g., World Trade Organization), national and state regulatory obligations, and the needs of other interested parties (e.g., industry, environmental groups, and the public). To make the best use of resources and time available, the Shrimp Virus Work Group recommends that a tiered approach be considered for conducting a shrimp virus ecological risk assessment. All interested parties (stakeholders) should be involved in both the initial planning phase of the risk assessment, risk characterization, and in subsequent discussions of risk mitigation options.

The Shrimp Virus Work Group recommends the following steps prior to initiating the risk assessment.

- Publish a scoping notice to inform the public about the issues and the availability of this report.
- Hold at least two public meetings to inform the public and to facilitate stakeholder input to management goals and the risk assessment process.
- Convene a workshop to develop a problem formulation for the risk assessment, using this report and additional information (e.g., from stakeholder meetings). This workshop should include experts from a range of disciplines and affiliations.

Other actions are needed to effectively manage the shrimp virus problem. The Shrimp Virus Work Group recommends increased coordination among Federal agencies having appropriate expertise and authority to protect U.S. marine resources from pathogenic shrimp viruses. These agencies need to work collaboratively to better utilize the resources currently available and to better define roles and responsibilities of individual agencies. Existing Federal statutory authority may not be adequate to prevent further disease outbreaks, and new authorities may be necessary. However, statutory authorities alone will not be sufficient to control new diseases. There is a need to implement complementary programs across the responsible Federal agencies as well as to enhance research and technology to effectively reduce the risk of disease outbreaks. The shrimp virus work group recommends that representatives of the responsible

Federal agencies work closely with the aquaculture, processing, and harvesting industries (as well environmental organizations and other interested parties) to explore a variety of opportunities to reduce the risks posed by shrimp viruses.